Short Resume of the Synopsis

"A Study on Inventory Control System for Deteriorating Items in Republic of Yemen"

1. Introduction

In general, Inventory control refers to idle goods or materials detained by an organization for use sometimes in future. Items carried inventory include raw materials, purchased parts, components subassemblies, work in process, finished goods, supplies. Some reasons organizations maintain inventory include the difficulties in precisely preceding sales levels production times, demand, usage needs. Thus, inventory serves as a buffer against uncertain and fluctuation usage and keeps a supply of items available in case the items are needed by the organization or its customers. Even though inventory servers an important and essential role the expenses associated with financing and maintaining inventories is substantial part of the cost doing business [1].

In real life, there are many things have deterioration such as chemicals, volatile liquids, bank of blood, medicines and some other goods during shortage period is non-negligible [2]. Deterioration is defined as decay, damage and it decreases usefulness so, the management and holding of inventories of perishable items becomes an important problem for inventory manager. On the other hand, delayed payment is an important from financing for business in aboard range of industries and Economics that extremely well developed and is being used in financial markets. Furthermore, both inflation and time value of money issue will have main effect in financial markets [3].

The elements of study are mentioned as following:

- Deterioration items.

- Delayed payment.
- Inflation and time value of money are separately regarded to in some inventory model.

All of the above mentioned issues are separately regarded in some inventory models. But there are few researches in which only the number of all considered topics are mentioned together. Yung [7] developed two warehouse inventory management problem for perishable products with constant demand rate and backordering shortages under inflation .Yung's research in constant to the traditional deterministic two warehouse inventory model with shortages at the end of each replenishment cycle ,an alternative model in which cycle begins with shortages and ends without shortages is proposed by author .Hou [10] developed an EOQ model over finite planning horizon for perishable products with stock-depend demand rate and full backordering under inflation and time value money. Ghosh and Chauhuri [11] developed an EOQ model with quadratic demand, shortages and time proportional deterioration in all cycles while Mukhopadhyay et al.[15] developed and EOQ model for perishable items in which demand is price dependent. Mohan and Gopala Krihnan [18] proposed a multi-products EOQ model with delayed payment and budget limitation. Jamal et. al. [17] developed EOQ model for perishable products whereas partial backordering, linear trend in demand and inflation are assumed .Chen and Kang [16] developed and integrated inventory control model with permissible delay in payment for determining the optimal order quantity time and replenishment frequency. Cheng et. al. [13] developed an inventory control model for deteriorating item in which trapezoidal type-demand and partial backlogging are assumed. Urban [12] developed the work on an extension of inventory models incorporating financing agreement with both supplier and customers.

1.1Assumptions & Notations

Some of the assumptions &notations are stated below [3]:

- During permissible period are continuous decision variables.
- The number of replenishment are restricted to integer one.
- The total Single item control is mentioned.
- Demand and deterioration rate are constant.
- Deterioration occurs as soon as the item received into inventory.
- There is no replenishment inventory backorder.
- Delayed payment strategy is offered by seller.
- Inflation rate is constant items during the period under the consideration; shortage is allowed and will totally.
- Planning horizon is finite.
- Sales revenue and time value of money is considered.
- The lead time is zero.
- The inventory level at the end of planning horizon will be zero.
- The cost factors are deterministic.
- The order and shortage quantity.
- Purchasing, holding, shortage interest payable & interest earned.
- Relevant cost consist fixed ordering.
- The last order is only being placed to satisfy the shortage of last period.
- The goal of model is to determine the decision variable under that present value of total cost during the horizon planning is minimized.

1.2 Parameters

A: the fixed ordering cost per replenishment, $/order [3].

C: the unit purchasing price at time zero/item.

C (t): the unit purchasing price at time t, C (t) = ce^{-Rt}.

D (t): the constant demand rate per unite time.

H: the length of finite planning horizon.

P (t) A single is produced at rate which is as function of time.

i: the constant inflation rate .

I (t): the inventory level at time t.

Ic: the interest charged per $ per year by supplier.

Ih: the holding cost rate per unit time including interest charges.

Ie: interest charged per $ per year by purchaser.

M: the permissible delay in setting account.

r: the discount rate representing the time value of money.

R: (r-i) representing the net constant discount rate inflation.

T: the length of each replenishment cycle.

Tj: the total time that is elapsed up &including the j^{th} replenishment cycle where T_0 , T_1, T_N .

t_j : The time at which the inventory level in j^{th} replenishment cycle drops to zero.

V: the unit selling price per unit at time zero, $/item.

V (t): the selling price per unit at time t, V (t)= Ve^{-Rt} .

¯ (t): the constant deterioration rate, units/unit time.

Π : The shortage cost per unit time,$/unit/unit time.

Π (t): the shortage cost per unit per unit time at time t , $\Pi(t) = \Pi e^{-Rt}$.

1.3 Decision Variable

F: the fraction of replenishment cycle where the net stock is positive.

N: the number of replenishments during the planning horizon, $N = \frac{H}{T}$.

- **Dependent Variable**

C_S : The present value of shortage cost during first replenishment cycle.

C_p : The present value of holding cost during first replenishment cycle.

I_b : The maximum shortage quantity.

I_m : The maximum inventory level.

IC: the interest payable during first replenishment cycle .

IE: the interest earned during first replenishment cycle.

Q: the order quantity in each the replenishment.

TC_A : The total ordering cost during interval (0, H).

TC_h : The total holding cost during interval (0, H).

TC_P : The total purchasing cost during interval (0, H).

TC_S : The total shortage cost during interval (0, H).

TIC: The total interest cost during interval (0,H).

TIE: The total interest earned cost during interval (0, H).

TC: The total relevant cost during interval (0, H).

1.4 Models Formulation of the study

- The general model formulation is [4]:

➢ $\frac{dI}{dt} = (1-\sim)\, p(t) - D(t) - \bar{}(t) I(t)$, $0 \le t \le t1, 0 \le \sim \le 1$

- The special model is [3]:

➢ $\frac{dI}{dt} + \bar{} I(t) = -D, 0 \le t \le t_1$

D(t)=a+bt, $a \ge 0, b > 0$, $0 \le \bar{} \le 1$

Considering the boundary condition, $I(t_1) = 0$

2. Literature Review

In inventory control, Ghare and Schrader [19] were pioneers to establish an inventory model for deteriorating items. Deteriorating items in which shortage was not permitted. Hariga and Ben–day [6] developed a lot sizing problem with time dependent demand under inflationary conditions. Ray and Chaudhari [9]developed a finite time horizon EOQ model with backordering where the varying demand rate whereas the effect inflation and the time value of the money are taken in to account. Chen [8] considered situation in which the demand rate is time proportional and shortage are fully Backordered .He investigated the effects of inflation and time. Chung [7] due to global warming, environmental consciousness and shorting product life cycles, more attentions have been paid to ecological protection and resource utilization green products and production process design significantly influence the environment and resources re-usage.

Some of the researchers focuses on deterioration cases related to deterioration rate in inventory such as Shah and Jaiswal [22], Aggarwal [5] ,Dave and Patel [20], Sachan [23], Goyal and Giri [24]. However, many of them have taken partially with some of many of the above issues have been made by researchers. Among these are Hariga [6] has developed three dynamic programming models for three commonly lot size models with non-stationary demand over finite planning horizon. An investigation on finite horizon EOQ model with equal parts, constant deterioration rate, linear time independent rate, allowing complete backordered shortages, and incorporating the effect of inflation and time value of money has been also introduced by Bose et al [25].

Also, Chung [11] and lin [7] have developed similar inventory model like Bose et ale's model for deterioration items taking account of time of value of money over a fixed planning horizon of equal parts with

complete backlogging and without backlogging and proved that the total variable cost is convex. Likewise Moon and Lee [14] have studied the effects of inflation and time value of money over a finite horizon EOQ model but for random product life cycle. In different aspects where the demand is decreasing function of the item price, Wee and Law [26] have also investigated a finite horizon inventory model for an item deteriorates over time. Although some pervious research has dealt with inventory problems under inflationary conditions, no one of the above mentioned articles considered the case where the production rate many very with time and where the production quantities may be imperfect. Balkhi and Benkherouf [21] presented an EOQ model with constant deterioration rate, but both demand and production rates are arbitrary function of time and shortages are allowed and completely backordered.

3. Research Objectives

Some of the objectives of the research study are

- ❖ To derive the optimal order quantities& shortage quantities and deterioration rate is function of time when
  - When the demand rate is linear function,
  - When the demand rate is Non-linear function.
- ❖ To derive and try to develop the optimal order quantities, shortage quantities when the demand rate is nonlinear, deterioration rate is constant.
- ❖ To obtain the optimal order quantities, shortage is not allowed function, demand rate is nonlinear.
- ❖ Try to develop the optimal costs including inventory cost, holding cost &shortage cost, purchasing cost, interest cost and interest earned cost.
- ❖ To find optimal order quantity for one price break, multi-price breaks, if they are possible.

- ❖ To analyze the sensitivity analysis by numerical example.
- ❖ Try to develop the management order economic quantity in case deterioration items.
- ❖ Try to develop model for real life data set for Yemen situated industries quantity in case deterioration items.

4. Research methodology

- ➢ Differential equation technique will be used to find the general solution and special solution for our two differential equations by using Bernoulli equation over the bounded of time when the shortage is allowed or not allowed.
- ➢ Simulation technique will be implemented for finding quantities based in special equations when shortages or without shortages allowed based on the inventory level.
- ➢ Goodness of fit for the demand rate by using the distribution theory technique based in the data which is collected by using Chi-square test.
- ➢ Regression analysis technique to estimate the demand rate, deterioration as linear or nonlinear regression for the data which is collected.

5. Significance of Research

- ❖ It can be used to find minimum deterioration for goods (permissible quality) and optimal quantity to satisfy the customers based on the data which is collected.
- ❖ This research can determine price break for the some goods have deterioration by finding optimal quantity.

- It can manage all goods have deterioration through optimal quantity, optimal inventory cost in republic of Yemen by represent the best model for the demand rate, deterioration rate.
- It can be applicable for Yemen situated industries for their development &it will help to increase the profit of the industries.

5.1Applications

Some of application of the study is stated below:

- It can use it in all chemical inventory include goods have deterioration and some medicines.
- It can use it to manage the problems in bank of blood.
- It can use it in marketing of fruits and vegetables.
- It can control the quantities in stocked.
- It can minimize the deterioration rate to get the best quality of the items.
- It will be tried to development the EOQ model based in the deterioration rate and demand rate.
- It can use to increase the profits by finding the optimal cost associated to purchase cost, holding cost and carrying cost.
- It can handle the many situations for deteriorating items with inflation.
- It can estimate the effects of the parameters together , changes on the derived results by the proposed methods ,a sensitive analysis is performed by changing the values of some parameters and taking one parameter at a time ,keeping remaining parameters at their original levels .This analysis is performed on numerical examples.

6. Provisional time table for the research study

Time period	Anticipated activities
First Year December 2016-March 2017	• Discuss the topic with supervisor. • Receive the clearance from supervisor to proceed. • Aim to complete chapter one.
April-July 2017	In depth reading around topic areas such as • The problems in an inventory control system. • Data collection. • The problems in inventory control system in Yemen. • The most goods have deterioration in inventories.
August 2017-December 2017	In depth reading around topic area such as • Historical problems in inventory control. Associated to goods have deterioration. • The order quantity model in case of demand is deterministic. • The mathematical model for total inventory cost model & Differential equation can be used to model the total inventory cost.
Second Year January 2018 – March 2018	In depth read around topic such as • Order decision. • Sensitivity Analysis for the EOQ. • Quantity discount for the EOQ model.
April 2018–July 2018	• Study and analysis of selected tables.
August 2018-December 2018	• Preparing and drafting of literature Review.
Third Year January 2019-April 2019	• Begin planning write up. • Receive feedback on draft main chapters. • Publication of research articles.
May 2019-July 2019	• Final write up.
August 2019 – November 2019	• Final revision begins after proofreading. • Completion of write up. • Print –Bind-submits.

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